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Original Research

Analysis of morphometric characteristics of aortic bifurcation: Computed tomography angiography study

Morphology of aortic bifurcation

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Abstract

Aim: The aim of this study was to determine the diameter and angle of the aortic bifurcation (AB) and its level in relation to the lumbar vertebra to provide useful information to surgeons interested in this region and contribute to the existing literature.

Material and Methods: Computed tomography angiography (CTA) images of 299 patients (156 females, 143 males) retrieved from Gaziantep University Hospital archives were reviewed. The long- and short-axis diameters of the AB were measured on two-dimensional images. The internal and external angles and the vertebral level of the AB were measured on three-dimensional reconstructions.

Results: The mean age of patients was 49.85 ± 18.74 years (range: 5 – 89). AB was most commonly observed at the middle L4 level (25.76%). The mean short-axis diameter of the AB was 1.29±0.26 cm, and the long-axis diameter of the AB was 1.92 ± 0.62 cm. Both diameter values were significantly greater in males than in females ($p<0.05$). The mean internal angle of the AB was 41.74±10.81°, and the mean external angle of the AB was 36.97±4.85°, with no significant difference between sexes ($p>0.05$). While the short-axis diameter of the AB and both internal and external angle values showed a very weak positive correlation with age, a moderate positive correlation was found between the long-axis diameter of the AB and age ($0<r<0.2$; $p<0.05$).

Discussion: Providing further insight into the morphology and morphometry of the AB, this study is expected to be useful in preoperative assessment and stent selection in anterior lumbar spine surgeries and endovascular aortic repair treatments.

Keywords

Aortic Bifurcation, Angle, Diameter, Computed Tomography Angiography

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Introduction

Morphometry of the aortic bifurcation (AB) influences the blood flow area, which is a significant factor affecting arteriogenesis [1]. Changes in AB geometry may lead to aneurysms, atherosclerosis, or aortoiliac calcification [2]. Moreover, the knowledge of the anatomy of the AB is critically important for successful endovascular aortic repair (EVAR) [2]. Anatomic variations may create mismatches, particularly in adjusting the size of the aortic stent grafts used in EVAR. Therefore, further anatomical data are required for the design of stent grafts of appropriate dimensions in the future [2, 3].

The relationship between the aortic bifurcation (AB) and the vertebral column is an important consideration for clinicians performing surgical interventions to the anterior lumbosacral region [1]. While the AB is most commonly found below the fourth lumbar (L4) vertebra, the vertebral level of bifurcation may vary among individuals between the L2 and the upper border of the first sacral vertebra (S1) [4].

There are studies suggesting that the diameter and level of the AB are associated with lumbar disk degeneration. Additionally, it has been reported that the diameter and angle of the AB are among the anatomical risk factors for the development of lower limb stenosis or occlusion after EVAR [5, 6].

This study aimed to establish the diameter and angle of the aortic bifurcation, and its level relative to the lumbar vertebrae in a sample of individuals from southern Turkey, and ultimately to provide useful information to surgeons and contribute to the literature.

Material and Methods

This study was conducted retrospectively on Computed Tomographic Angiography (CTA) images retrieved from the archives of Gaziantep University Faculty of Medicine Hospital. Approximately 2000 images from patients undergoing abdominal CTA between 2017 and 2022 for various reasons were reviewed. Inclusion criteria were the absence of any aortic pathology, no prior endovascular intervention or surgical procedure to the region of interest, and adequate image quality for measurements. Images with a slice thickness greater than 5 mm in which the structures were not clearly visible in three-dimensional reconstructions, images affected by motion artifacts, or images with insufficient distribution of contrast material within the artery that compromised image interpretation were excluded. Images from patients who underwent surgical and/or interventional procedures, or patients with vascular diseases affecting the AB segment such as vasculitis, aneurysm, atherosclerosis, and calcification were also excluded. In order to show the change of parameters with age, no age or sex restrictions were imposed in the study. Ultimately, a total of 299 patients (156 females and 143 males) meeting the criteria were included in the study. The mean age of the patients was 49.85 ± 18.74 years. Diameter measurements were conducted in the transverse plane on the 2D images. The AB angles and the vertebral level of the AB were determined using the 3D images.

Determination of the Aortic Bifurcation Level in Relation to the Lumbar Vertebrae

To establish the vertebral level, four planes were defined that included the lumbar vertebrae and intervertebral disk structures including upper (above the pedicle level of the vertebrae), middle (at the pedicle level of the vertebrae), lower (below the pedicle level of the vertebrae), and disk level (intervertebral disk level) [7] (Figure 1). The bifurcation point where the abdominal aorta (AA) branches into the common iliac arteries was marked, and the level of the aortic bifurcation was determined based on the corresponding plane on the vertebrae.

Angle and Diameter Measurements of the Aortic Bifurcation

The long- and short-axis diameters of the aortic bifurcation (AB) were measured in the transverse plane (Figure 2).

In addition, the bifurcation angles of the AB were measured in two ways. First, the point of the aortic bifurcation (PAB) was determined. To identify the starting points of the right common iliac artery (RCIA) and the left common iliac artery (LCIA), a maximum- radius circle was placed in the bifurcation pool. The maximum-radius circle was tangent to three points in the bifurcation pool, one at PAB, one at the RCIA- abdominal aorta (AA) vessel surface, and the other at the LCIA-AA vessel surface. A maximum-radius circle was placed on the RCIA and LCIA vessel lumens, with its center on this bifurcation circle. Subsequent maximum-radius circles were tangent to the centers of the initial circles. The vector passing through the center points of the first and second circles was considered as the central axis of the RCIA. The same procedure was repeated for the LCIA. The angle between the central axes of these two vessels forming the bifurcation was defined as the first aortic bifurcation angle (ABA1) (Figure 3) [https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp].

Then, the second aortic bifurcation angle (ABA2) was measured. The angle between tangent lines drawn on the vessel surfaces of RCIA and LCIA facing each other was defined as ABA2 (Figure 3) [https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp].

Statistical Analysis

The descriptive statistics of the study data were reported as mean and standard deviation for numerical variables, and frequency and percentage for categorical variables. The normality of the AB measurements was checked using the Shapiro-Wilk test. The independent samples t-test or Mann-Whitney U test was used to compare the categorical variables between the two groups as appropriate. Differences between the data for categorical variables were analyzed using the chi-square test. Additionally, relationships between the numerical variables were examined using Pearson's correlation analysis or Spearman's correlation analysis. Due to the limited number of patients in some age groups, the differences in parameters could not be analyzed according to age groups. All statistical analyses were conducted using the SPSS 22.0 (IBM Corp., Armonk, NY), and the significance level was set at $p < 0.05$.

Ethical approval dated 2022-11-03 and numbered 2022/164 was obtained from the Ethics Committee for Non-Invasive Clinical Research of Gaziantep Islam Science and Technology University.

Ethical Approval

Ethics Committee approval for the study was obtained.

Results

The AB was most commonly observed at the L4 middle level (n=76, 25.76%), followed by the upper L4 level (n=70, 23.73%) and the lower L4 level (n=67, 22.71%). The least common AB levels were middle L3 and upper L5 (n=4 each, 1.36%), and middle L5 (n=1, 0.34%) (Table 1).

The mean short-axis diameter of the AB was 1.29 ± 0.26 cm, while the mean long-axis AB diameter was 1.92 ± 0.62 cm. Both diameter values were significantly greater in males than females ($p<0.05$) (Table 2). The mean internal angle of the AB was 41.74° ± 10.81°, while the external AB angle was 36.97° ± 14.85°. There was no significant difference between the sexes in terms of internal and external AB angles ($p>0.05$) (Table 2).

Correlation analysis revealed a statistically significant, moderate positive correlation between the long-axis diameter of the AB and age ($0.4<r<0.6$; $p<0.05$). A very weak positive correlation was observed between the short-axis diameter of the AB and age, which was statistically significant ($0<r<0.2$; $p<0.05$) (Table 3). A very weak positive correlation was found between both AB angles and age, which was statistically significant ($0<r<0.2$; $p<0.05$) (Table 3).

Table 1. Distribution of vertebral levels of the aortic bifurcation.

Vertebral Level	Number	Percentage
Middle L3	4	1.36
Lower L3	15	5.08
L3-4	38	12.88
Upper L4	70	23.73
Middle L4	76	25.76
Lower L4	67	22.71
L4-5	20	6.78
Upper L5	4	1.36
Middle L5	1	0.34

Table 2. Distribution of the diameter and angle measurements of the aortic bifurcation by sex.

	Females Mean ± SD	Males Mean ± SD	Overall Mean ± SD	p
Long-axis diameter of AB (cm)	1.87±0.77	1.97±0.39	1.92 ± 0.62	0.001*‡
Short-axis diameter of AB (cm)	1.24±0.24	1.34±0.27	1.29 ± 0.26	0.001*‡
Internal angle of AB (degrees, °)	41.97±11.1	41.48±10.53	41.74 ± 10.81	0.591‡
External angle of AB (degrees, °)	37.5±15.18	36.38±14.5	36.97 ± 14.85	0.591‡

*p<0.05; ‡Mann-Whitney U test, AB: Aortic bifurcation, SD: Standard deviation

Table 3. Correlations of diameter and angle values of aortic bifurcation with each other and age.

Parameters		Age	Long-axis diameter of AB	Short-axis diameter of AB
Long-axis diameter of AB	r	0.487		
	p	0.001*		
Short-axis diameter of AB	r	0.118		
	p	0.042*		
Internal angle of AB	r	0.17	0.137*	0.195*
	p	0.003*	0.019	0.001
External angle of AB	r	0.181	0.102	0.171*
	p	0.002*	0.080	0.003

*p<0.05; AB: Aortic bifurcation.

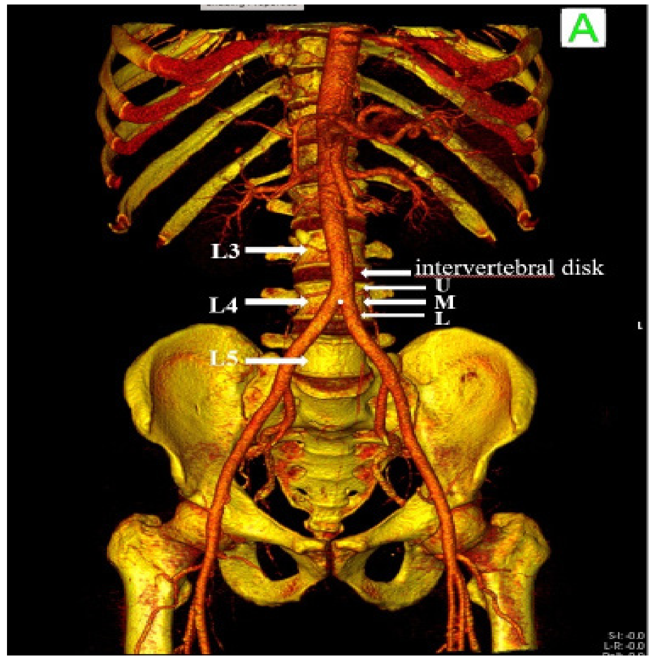

Figure 1. Assessment of the vertebral level of the aortic bifurcation (AB) on a 3D CTA image (anterior plane). U: upper, M: middle, L: lower.

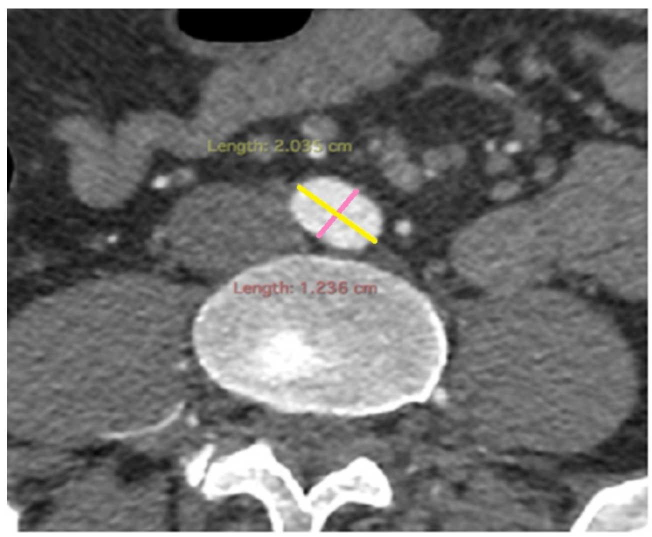

Figure 2. Measurement of the long-axis diameter (yellow arrow) and short-axis diameter (red arrow) of the AB on a 2D CTA image.

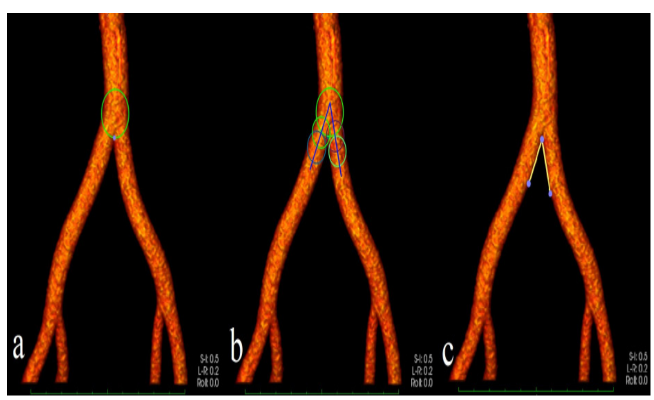

Figure 3. Measurement of the first aortic bifurcation angle (ABA1). a) Determining the AB point and placement of a maximum-radius circle in the bifurcation pool, b) Circles drawn on RCIA and LCIA and ABA1 measurement. c) Measurement of the second aortic bifurcation angle (ABA2).

Discussion

Vertebral levels of the aortic bifurcation

The success and/or challenges of anterior lumbar spine surgery and laparoscopic interventions performed at the L4-L5 intervertebral disk have been reported to be related to the prevertebral vascular anatomy, particularly the level of the aortic bifurcation. Studies conducted on cadavers to determine the vertebral levels of AB have reported mixed results. For example, in a study by Panagouli et al. involving 62 cadavers (32 males, 30 females), AB was most commonly found at the lower L4 level (n=19, 30.6%), and Deswal et al. who studied 25 cadavers (16 males, 9 females) found that the AB was most frequently located at the L4 vertebral level (n=16, 64%) between L3 and L5 [1, 4].

Computed tomography (CT) or CTA imaging modalities are reliable tools for characterizing vascular anatomy, and are widely used since they enable access to larger samples [8, 13]. In a study examining 180 CT images, Kornreich et al. reported that the vertebral level of AB was at the upper L4 in males and at the lower L4 in females. They found that the most common AB level was at the upper L4 (62 individuals) overall, and that the vertebral level of AB tended to be lower with increasing age [13]. In a study by Datta et al. involving 76 CTA images, the most common AB level was at the L4 vertebra (39 individuals). Similarly, using CT images of 108 individuals, Mirjalili et al. found that the most common AB level was at the middle L4 (65 individuals) [8, 9]. In a study by Gregory et al. analyzing 232 CTA images, AB was most frequently located at the L4 vertebral level (n=155) [12]. Goyal et al. reported that AB was most commonly observed at the upper L4 level (n=38) in a study of CT images of 100 individuals. Examining CTA images of 181 individuals (100 males, 81 females), Moussallem et al. reported that the AB was most commonly found at the L4-5 disk level (63 individuals) [11, 14].

Chithriki et al. investigated the level of AB in relation to the vertebrae using magnetic resonance (MR) images, and reported that in 441 images, the most common AB level was at the L4 vertebra (n=295, 67%) [15]. Consistently, in a study of MR images of 100 individuals, Molinares et al. observed that the most common vertebral level of AB was at the middle L4 (n=33) [16]. Therefore, the findings of the present study are in line with previous reports.

Angle of aortic bifurcation

The measurement of the abdominal aorta (AA) diameter can be used to predict a number of diseases such as aneurysms and atherosclerosis in the clinical setting [17, 18]. Additionally, the diameter of the aortic bifurcation should also be evaluated for the risk of lower limb stenosis following endovascular treatment [5].

Drewe et al. employed computational fluid dynamics techniques to investigate the effect of AA geometry on abdominal aortic aneurysm (AAA) by examining the relationship between the AB angle and AAA. They found that as the AB angle increased, there was an increase in wall shear stress and a decrease in endothelial cell activation. As a result, they suggested that a larger AB angle could potentially offer protection against the expansion and rupture of AAA through higher wall shear stress and reduced endothelial cell activation [19].

In another study that examined the AB angle in 26 patients with aortoiliac atherosclerotic disease and 33 control subjects, it was reported that the mean AB angle of the sample was 44.30±14.77°. The study found that patients with atherosclerosis had narrower AB angles compared to healthy individuals, and the AB angle was identified as an independent risk factor for aortoiliac atherosclerosis [6]. Additionally, in a study comparing aortoiliac atherosclerotic disease between Eastern and Western countries, it was noted that the AB angle is a significant risk factor for this disease. AB angles were greater in patients from Eastern countries, which suggests the need to use different treatment techniques in these two populations taking into account this anatomical difference [2].

There are studies reporting that the technical success of the Outback reentry device for femoropopliteal artery occlusion in contralateral and ipsilateral approaches is significantly influenced by the angle of the aortic bifurcation [14].

Moussallem et al. investigated the relationship between lumbar lordosis angle and the vertebral level of the AB on CTA images from 181 individuals (100 males, 81 females). They reported that the mean AB angle was 47.43°. Furthermore, they found a moderate positive correlation between age and the AB angle that was statistically significant [14].

In a study involving 232 children ranging in age from newborn to 19 years, the relationship between the abdominal aorta and the vertebral column was examined on CT images. The mean AB angle was 48.4°, and as age increased, the AB angle decreased. The study observed differences in the vertebral level and geometry of the abdominal aorta, pointing out that narrower AB angles were found at higher levels of the AB. The study suggested that this finding could have a favorable impact on pediatric surgical approaches involving endovascular procedures [12].

In a study by Deswal et al. on cadavers (16 males, 9 females), the mean AB angle was 50.16° ± 8.64° for the entire sample, 49.37° ± 10.34° for males and 51.55° ± 4.50° for females. No significant difference was found in mean AB angle between males and females [1].

In the current study, in line with the literature, AB angles did not show a statistically significant difference between sexes ($p > 0.05$). This study also found a very weak positive correlation between the AB angles of the AA and age, with statistical significance ($0 < r < 0.2$; $p < 0.05$), which is consistent with Gregory et al. and Moussallem et al.'s findings ($0<r<0.2$; $p<0.05$).

Aortic bifurcation diameter

In a study on CTA images, a significant increase in the AB diameter was found in both males and females with increasing age, with males showing greater AB diameters than females [21].

A cohort study examining CT scans of 3692 healthy Asian individuals reported that the mean AB diameter was 16.34±2.24 mm overall, 17.18±2.01 mm for males, and 14.81±1.78 mm for females, with a significant difference observed between sexes. Multilinear regression analysis showed that age, sex, and body surface area affected the mean AB diameter [22].

In a study on the adult Nigerian population, the mean AB diameter was 1.29 ± 0.23 cm, with significantly greater values found in males than in females [23]. Reviewing CTA images from 625 middle-aged or older individuals (380 males, 245 females), Hu et al. reported a mean aortic diameter of 15.45 ± 2.90 mm, which was measured just above the AB. They observed that the AB diameters were significantly greater among males compared to females, with diameter values increasing with advancing age [24].

In the present study, consistent with the literature, when the AB diameter was evaluated by sex, a statistically significant difference was observed, with greater diameter values found in males than in females. In addition, the AB diameter values showed a positive correlation with age, with AB diameters increasing with age. Therefore, our findings are in line with previous reports.

Limitations

It was applied to individuals who applied to the hospital with any complaint but did not have any pathology in the abdominal aorta and aortic bifurcation.

Since this study was designed as a retrospective, demographic information and the presence of any other disease that could affect the morphometry of the aortic bifurcation could not be obtained.

Conclusion

By examining the vertebral levels of the aortic bifurcation and measuring its diameter and angles, this study provided relevant data regarding AB morphology and morphometrics to the literature. It is our belief that the anatomical insights obtained from this study will be useful for clinicians performing anterior lumbar spine surgeries and endovascular aortic repair treatments. For a successful surgical intervention with fewer complications, individual geometric characteristics of the aortic bifurcation area should be considered during preoperative assessment and appropriate stent selection.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and Human Rights Statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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Conflict of Interest

The authors declare that there is no conflict of interest.

References

1. Deswal A, Tamang BK, Bala A. Study of aortic- common iliac bifurcation and its clinical significance. J Clin Diagn Res. 2014;8(7):6-8.
2. Joh JH, Cho S. A Comparison of Aortoiliac Disease between Eastern and Western Countries. Vasc Specialist Int. 2019;35(4):184-8.
3. Banzic I, Lu Q, Zhang L, Stepak H, Davidovic L, Oszkinis G, et al. Morphological Differences in the Aorto-iliac Segment in AAA Patients of Caucasian and Asian Origin. Eur J Vasc Endovasc Surg. 2016;51(6):783-9.
4. Panagouli E, Antonopoulos I, Tsoucalas G, Chrysikos D, Samolis A, Protogerouet V. et al. Case series and a systematic review concerning the level of the aortic bifurcation. Folia Morphol (Warsz). 2021;80(2):302-9.
5. Marques De Marino P, Martinez Lopez I, Pla Sanchez F, Cernuda Artero I, Cabrero Fernandez M, Ucles Cabeza O, et al. Endovascular treatment of abdominal aortic aneurysms with narrow aortic bifurcation using Excluder bifurcated stent grafts. J Vasc Surg. 2018;67(1):113-8.
6. Shakeri A, Shakeri M, Ojaghzadeh Behrooz M, Behzadmehr R, Ostadi Z, Fouladi DF. Infrarenal aortic diameter, aortoiliac bifurcation level and lumbar disc degenerative changes: a cross-sectional MR study. Eur Spine J. 2018;27(5):1096-104.
7. Ekingen A, Hatipoğlu ES, Hamidi C. Distance measurements and origin levels of the coeliac trunk, superior mesenteric artery, and inferior mesenteric artery by multiple-detector computed tomography angiography. Anat Sci Int. 2021;96(1):132-41.
8. Ali Mirjalili S, McFadden SL, Buckenham T, Stringer MD. A reappraisal of adult abdominal surface anatomy. Clinical Anatomy. 2012;25(7):844-50.
9. Datta JC, Janssen ME, Beckham R, Ponce C. The Use of Computed Tomography Angiography to Define the Prevertebral Vascular Anatomy Prior to Anterior Lumbar Procedures. Spine. 2007;32(1):113-9.
10. Ekingen A, Çetinçakmak MG. Level of Variations of the Aortic Bifurcation and Distance Measurements between the Aortic Bifurcation and the Common Iliac Bifurcations. Journal of the Anatomical Society of India. 2022;71(1):11-7.
11. Goyal R, Aggarwal A, Gupta T, Gulati A, Jaggi S, Mirjalili SA, et al. Reappraisal of the classical abdominal anatomical landmarks using in vivo computerized tomography imaging. Surg Radiol Anat. 2020;42(4):417-28.
12. Gregory LS, McGifford OJ, Jones LV. Differential growth patterns of the abdominal aorta and vertebrae during childhood. Clin Anat. 2019;32(6):783-93.
13. Kornreich L, Hadar H, Sulkes J, Gornish M, Ackerman J, Gadoth N. Effect of normal ageing on the sites of aortic bifurcation and inferior vena cava confluence: a CT study. Surg Radiol Anat. 1998;20(1):63-8.
14. Moussallem CD, Hamad IA, El-Yahchouchi CA, Moussallem MD, Arnalsteen DM, Mertlet P, et al. Relationship of the lumbar lordosis angle to the abdominal aortic bifurcation and inferior vena cava confluence levels. Clin Anat. 2012;25(7):866-71.
15. Chithriki M, Jaibaji M, Steele R. The anatomical relationship of the aortic bifurcation to the lumbar vertebrae: a MRI study. Surgical and Radiologic Anatomy. 2002;24(5):308-12.
16. Molinares DM, Davis TT, Fung DA. Retroperitoneal oblique corridor to the L2-S1 intervertebral discs: an MRI study. J Neurosurg Spine. 2016;24(2):248-55.
17. Arbănași EM, Mureșan AV, Coșarcă CM, Arbănași EM, Niculescu R, Voidăzan ST, et al. Computed Tomography Angiography Markers and Intraluminal Thrombus Morphology as Predictors of Abdominal Aortic Aneurysm Rupture. Int J Environ Res Public Health. 2022;19(23): 15961.
18. Minichil F, Tesfaye K, Zeleke H. Preliminary Understanding of Abdominal Aortic and Common Iliac Artery Diameters on Abdominal CT in Ethiopian Adults: A Facility-Based Cross-Sectional Study. Ethiop J Health Sci. 2022;32(Spec Iss 1):17-26.
19. Drewe CJ, Parker LP, Kelsey LJ, Norman PE, Powell JT, Doyle BJ. Haemodynamics and stresses in abdominal aortic aneurysms: A fluid-structure interaction study into the effect of proximal neck and iliac bifurcation angle. J Biomech. 2017;60:150-6.
20. Raskin D, Khaitovich B, Balan S, Silverberg D, Halak M, Rimon U. The Aortic Bifurcation Angle as a Factor in Application of the Outback for Femoropopliteal Lesions in Ipsilateral Versus Contralateral Approaches. Cardiovasc Intervent Radiol. 2018;41(1):37-42.
21. Góes AMO, de Albuquerque FBA, Beckmann FA, Centeno FV, de Andrade MC, Vieira WB. Age and sex and their influence on the anatomy of the abdominal aorta and its branches. J Vasc Bras. 2020;19:e20200073.
22. Kim H, Kwon TW, Choi E, Jeong S, Kim HK, Han Y, et al. Aortoiliac diameter and length in a healthy cohort. PLoS One. 2022;17(5):e0268077.
23. Ezenwugo UM, Okwudire EG, Njeze NR, Maduforo CO, Moemenam OO. Abdominal aortic diameter and its determinants among healthy adults in Port Harcourt, Nigeria. Niger J Clin Pract. 2020;23(3):310-4.
24. Hu J, Zheng ZF, Zhou XT, Liu YZ, Sun ZM, Zhen YS, et al. Normal diameters of abdominal aorta and common iliac artery in middle-aged and elderly Chinese Han people based on CTA. Medicine (Baltimore). 2022;101(31):e30026.

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